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Impact of foot-and-mouth disease on milk production on a large-scale dairy farm in Kenya

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ABSTRACT

The economic impact of foot-and-mouth disease (FMD) has been poorly characterised particularly in endemic settings where such knowledge is important for decision-making on disease control with limited resources. In order to address this, a study was designed using individual animal data from a large-scale dairy farm in Kenya to estimate the impact of an FMD outbreak due to serotype SAT2 virus on milk yield. Daily milk yields from 218 mainly European-breed cattle that were lactating during the 29-day outbreak period were considered in the analysis. At the herd level, the average daily yields decreased from around 20 to 13 kg per cow, recovering approximately 2 months after the commencement of the outbreak. Generalised estimating equations (GEE) and an autoregressive correlation matrix were used to compare yields of reported clinical FMD cases and non-cases. No difference was found between reported clinical and non-clinical cases suggesting inaccurate case recording, poor sensitivity of the case definition and subclinical infections being present. To further investigate the impact of FMD, yields were predicted for each individual animal based on historic data from the same herd using a similar GEE approach. For cattle lactating during the outbreak, comparisons were made between actual and predicted yields from the commencement of the outbreak to 305 days lactation using a linear regression model. Animals produced significantly less than predicted if in parity 2 or greater and between 0 and 50 days in milk (DIM) at the start of the outbreak period. The maximum effect was seen among animals in parity $\geq$4 and between 0 and 50 DIM at the start of the outbreak, producing on average 688.7 kg (95%CI 395.5, 981.8) less milk than predicted for their remaining lactation, representing an average 15% reduction in the 305 day production for these animals.

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Generalisation of the results requires caution as the majority of Kenyan milk is produced in smallholder farms. However, such farms use similar genetics and feeding practices to the study farm, and such systems are increasingly important in the supply of milk globally. These results make an important and unique contribution to the evidence base on FMD impact among dairy cattle in an endemic setting.

1. Introduction

Foot-and-mouth Disease (FMD) is caused by a highly transmissible viral infection of cloven-hooved animals responsible for economically devastating outbreaks when introduced into FMD-free countries. Its impact in endemic counties is poorly characterised. Most of the world is endemic except for Europe, North America, Australia and New Zealand. The disease is characterised by lesions on the dental pad, tongue, muzzle, interdigital space and teats. These appear alongside initial pyrexia, dramatic reduction in milk yield and occasional abortion. Animals typically recover clinically within two weeks after onset, although secondary bacterial infection particularly in the feet and udder may lead to more protracted disease. It has been claimed that an animal will not recover to their full lactating potential for the remainder of the lactation (Kitching, 2002).

Quantifying the reduction in milk output due to FMD is fundamental to understanding its economic impact in dairy herds and therefore resource allocation for control in endemic settings. This loss has been poorly documented and is typically based on farm and expert opinion (James and Rushton, 2002; Knight-Jones and Rushton, 2013). Table 1 summarises all the relevant studies that could be found in the literature. Studies have estimated milk loss in a variety of different settings and have used different approaches. In an FMD free setting, a cost-benefit evaluation in the UK estimated that the output of milk would be reduced by 25% in the first four years should the UK become endemic reducing to 12.5% in subsequent years (Power and Harris, 1973). In endemic settings, a survey of expert opinions in Turkey estimated on average a 22% milk yield loss per lactation in Holstein cattle if affected with FMD incurring a financial loss of 266USD (Şentürk and Yalçin, 2005, 2008). The estimated loss was lower for local breeds at 10% and 47USD, respectively. Using participatory epidemiological methods, studies among pastoralists have estimated yield reductions of 53% and 62% during the period of illness in Kenya and South Sudan, respectively (Barasa et al., 2008; Onono et al., 2013). Post-outbreak surveys in Ethiopia among pastoralist farmers owning Borana cows estimated an average drop in milk yield of 77.3% for an average 25.5 day period representing a 7.7% reduction for the whole lactation (Bayissa et al., 2011). In a chronic form of the condition, including a heat intolerance syndrome sequel to acute infection (Catley et al., 2004), the loss was estimated at 78% for the lactation. In another Ethiopian post-outbreak survey of pastoral and crop-livestock mixed farming, households reported an average loss of 1.8 litres/cow/day (Jemberu et al., 2014). This was based on farmer estimates prior to and during the outbreak and represented a 75% reduction that lasted for a mean of 23 days (range 7–35) and 33.6 days (range 7–90) in the respective farming systems. In India, post outbreak surveys estimated FMD to cause a reduction of the national milk output of 6.5% with a 14–19% reduction in the annual yield of an affected animal (Saxena, 1994).

Empirical data on milk yield impact have been presented in few settings. In Pakistan, examination of milk records for 77 Sahiwal cows revealed the average duration of milk loss to be 17.9 days with 74.4 litres of milk lost per affected lactation (Kazimi and Shah, 1980). Also in Pakistan, Ferrari et al. (2013) performed a longitudinal study following clinically affected cows and buffalo on 50 smallholder farms. A 60-day follow-up period post disease onset was evaluated and included 72 milking cows and 125 milking buffalo. They estimated that cows and buffalo produced only 51.8% and 55.4% of their milk yield potential during this period. A study among Bangladesh cattle found a reduction of average daily yields of 66% but the time period for this reduction was not clearly specified (Chowdbury et al., 1993). An investigation into an outbreak at a government owned farm in Ethiopia examined the daily yields of 14 indigenous Fogera cows affected with clinical FMD. A comparison of the yields produced 10 days period prior to disease with the 10 days after revealed an approximate 50% reduction between these two periods (Mazengia et al., 2010).

Kenya is endemic for FMDV with serotypes A, O, SAT1 and SAT2 being present in domestic species (Paton et al., 2009). A nationwide serosurvey performed in 2010 revealed a seroprevalence of 52.5% (Kibore et al., 2013). Kenyans are among the largest consumers of milk in the developing world and consume four times the average for sub-Saharan Africa (Smallholder Dairy Project, 2004). Despite the importance of the Kenyan dairy industry, the impact of FMD has been poorly characterised in the country. A study among Kenyan pastoralists ranked FMD and East coast fever as diseases with the highest impact on livelihoods (Onono et al., 2013). A case-report from a large scale farm in Kenya estimated milk loss to contribute 42% of the total cost of the outbreak in the 95 day period from the beginning of the outbreak although the method underlying this calculation is not clear (Mulei et al., 2001).

In August/September 2012, an outbreak of FMD due to serotype SAT2 occurred on a large scale dairy farm in Nakuru County as described elsewhere (Lyons et al., 2015). The regular recording of individual milk yields on this farm presented the opportunity to quantify objectively the impact of disease on milk yields. The objectives of the current study were to estimate the economic impact of FMD infection in commercial dairies by comparing the milk production between clinical FMD cases and non-cases using a